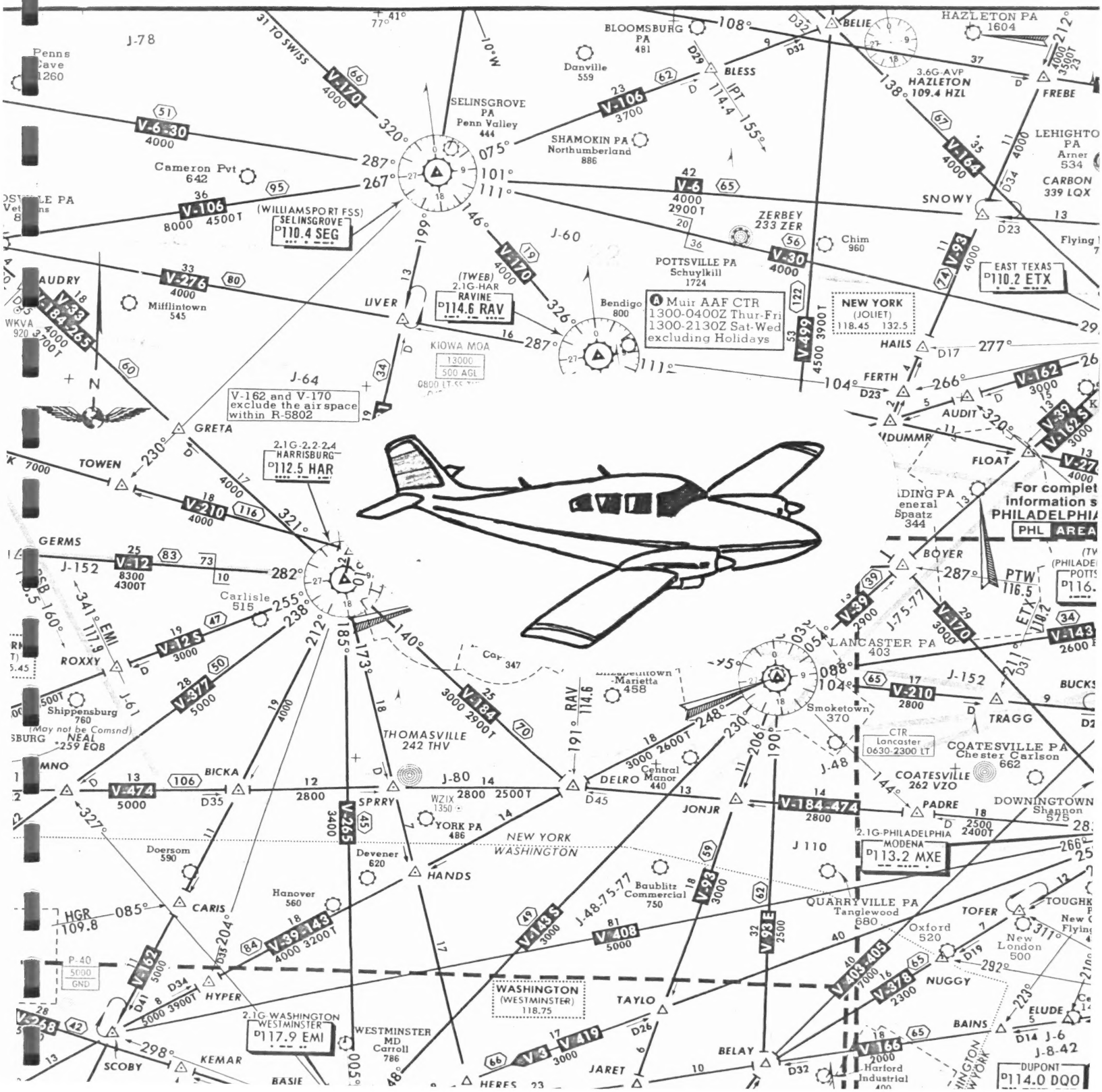
AREA NAVIGATION

RNAV Program for the HP 41C/CV

by

Robert A. Tims



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PROGRAM DESCRIPTION I

Program Title AREA NAVIGATION (RNAV)

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Program Description, Equations, Variables This program computes the magnetic course and distance between each leg's starting fix and its ending fix. RNAV waypoints along each leg's course can be computed, dividing the primary leg into two or more secondary legs. The program will compute a RNAV waypoint over the departure point and the destination. The total trip distance is computed.

Each primary leg consists of a starting and an ending navigation fix. A leg's starting fix will either be the departure point or the ending fix of the previous leg. A navigation fix may be defined by its latitude and longitude coordinates along with the appropriate magnetic variation; or by its magnetic direction and nautical distance from the previous fix (as in the case of an airway intersection); and if the previous fix isn't a practical reference, then the fix (such as a waypoint) can be defined in magnetic direction and

Necessary Accessories 2 memory modules; 1 memory module w/o card reader and printer

Operating Limits and Warnings A leg's starting fix must not be the same coordinates as its ending fix, i.e. the distance of a leg must be greater than zero.

Reference(s)

This program has been verified only with respect to the numerical example given in *Program Description II*. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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nautical distance from any given reference fix. The reference fix must be defined by latitude and longitude coordinates. In the last two cases the magnetic variation used in the program will be that of the prior fix, or of the reference fix if one is used.

Coordinate inputs are in degrees, minutes and seconds north or south of the equator, and east or west of the prime meridian. North latitude and west longitude are positive numbers. South latitude is a negative number. East longitude is a negative number; but with the card reader, east longitude can't be used with the present data format. Please see the appendix and Data Record Program Description I for more information. A Radial (or from bearing) used to define a fix is in degrees and a decimal fraction of a degree. All distances are in nautical miles.

Each fix is labeled with an assigned alpha "identifier." National location identifiers are usually three letters for airports and navigation aids and may be found in the Airport/Facility Directory and on avigation charts. Intersections are identified with a five letter name and may be found on avigation charts. The program will accept up to six letters to identify a fix. However, in the case of a waypoint, the identifier of the reference fix is appended to the characters "WP:" which means only the first three letters will be used.

If a card reader is being utilized the alpha identifiers are used to locate the proper coordinates in memory. However, even if a card reader isn't used, the identifiers are used in the prompts to avoid confusion and to help you keep track of the fix for which you are inputing data.

After the starting fix and the ending fix of each primary leg is defined, the program can be used to compute waypoints. Each waypoint will

be defined by a radial, that is perpendicular to the course, and the nautical distance from the navigational aid. When a waypoint is being computed the program will only allow the reference fix to be defined by latitude and longitude coordinates. Requested waypoints will be ignored by the program if the nav aid selected will place the waypoint before the leg's starting fix, beyond its ending fix, or behind a previously computed waypoint.

When asking for data, the program will first prompt for the primary leg's data and then compute the course and distance. After which it will prompt for the data necessary to compute waypoints. If waypoints are computed, then the primary leg will be divided into two or more secondary legs. The data will be displayed without distinction between primary and secondary legs. Each displayed leg will be from one navigation fix, intersection, or waypoint to the next one.

The display will show first the identifiers of the beginning and ending fix for the leg. The magnetic course will be displayed next. If the magnetic variation at the beginning of the leg is different than it is at the ending, both magnetic bearings will be displayed. The "from" bearing first, separated from the "to" bearing by the character "/". Bearings will be displayed to the nearest whole degree. The distance is then displayed to the nearest whole nautical mile. If the leg's ending fix is a RNAV waypoint, its data will follow after the leg's data. Its identifier, followed by the bearing and distance will be displayed. Both the waypoint bearing (radial) and the distance will be to the nearest tenth of a degree and nautical mile.

If the departure airport is defined by latitude and longitude coordinates, a waypoint located at the Airport Reference Point may be computed from any

given nav aid. This waypoint will be displayed before the first leg's data. A waypoint may be computed in the same manner for the destination airport, and will be displayed after the last leg. If the airport is defined as a bearing and distance from a reference nav aid, than by definition it is already a waypoint, and the program will not prompt for a terminal waypoint.

The final display will show the departure and destination identifiers and will display the total trip distance between them.

After the departure point is entered, any prompt thereafter may be declined by resuming program execution without any input. If data has mistakenly been entered, and execution has not been resumed, you may still decline the input by clearing the appropriate flag (flag 22 or 23), and then resuming program execution. When input is declined the program continues to the next phase.

A card reader is highly recommended in order to utilize the RNAV program to its fullest. It is more efficient to be able to enter a nav fix or a station's identifier and coordinates by magnetic card. The coordinates to VORTACs and often used airports may be stored on the cards and utilized with the program quickly and easily. A Data Record program is included so that station data can be recorded on the magnetic cards in the proper format.

The program will run without either a card reader or printer. In the appendix, variations to the program are given in order to reduce its size and execution time if either accessary is never used. Sometimes the printer may not be practical; however the program, especially with the magnetic cards, can compute course changes and new waypoints quickly and easily.

PROGRAM DESCRIPTION I

(CONTINUATION PAGE)

This program makes your flight planning easy and simple. Using an avigation chart, determine if you can go direct RNAV or if part of the trip will be on a convienient airway. Then determine which nav aids will be used for waypoint fixes along the RNAV portion. If a terminal waypoint is needed, pick the VORTAC closest to the airport. Then put the data into the RNAV program and the HP-41C/CV will compute your magnetic course, distance, and waypoints with as great or greater accuracy than can be obtained with a plotter and pencil.

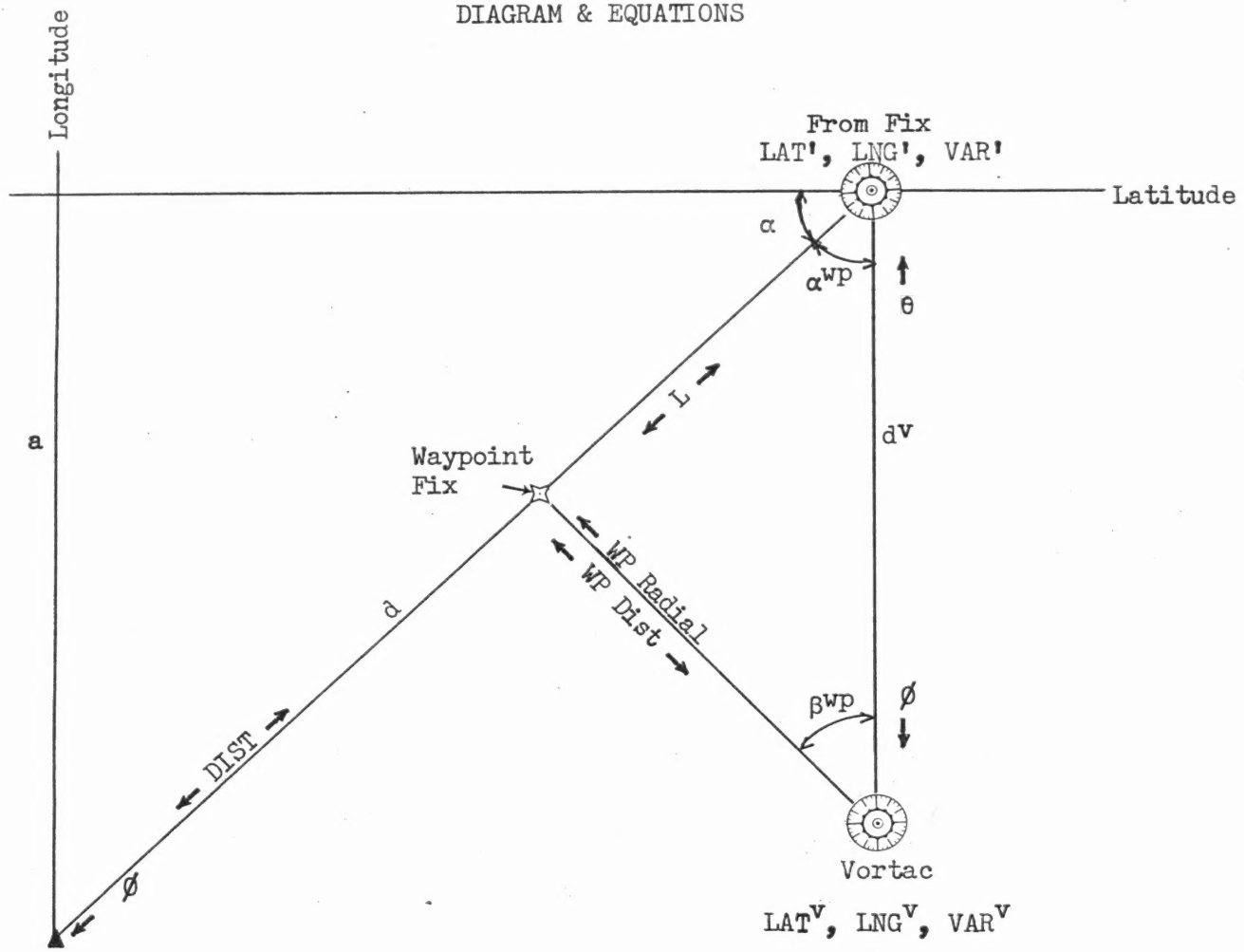
Three sample problems will be given. The first two will be a trip from the McGhee Tyson airport at Knoxville, TN to the Muscle Shoals, AL airport. The first will be without a printer or card reader, the second will be with them. The last sample problem will be a navigation problem that could result if one had to divert off course. If one diverted north of the previous course to a position 12 NM DME on the Hinch Mountain VORTAC 240° radial and then received a direct clearance to the Muscle Shoals VORTAC will illustrate how easy it is to compute a course change. The sample problems are illustrated on part of an avigation chart. The facilities used in the RNAV sample problems are recorded on a magnetic card in the Data Record Program Description II sample problem.

Westerly magnetic variation is a positive number while Easterly variation is a negative number.

PROGRAM DESCRIPTION I

(CONTINUATION PAGE)

DIAGRAM & EQUATIONS



WP Radial = $\theta^V \pm \beta^{WP} + VAR^V$

WP Dist = $60 \sin^{-1} (\sin |\alpha^{WP}| \sin d^V)$

$$LAT = LAT' + \sin^{-1}[(\sin d)(\cos \emptyset)]$$

$$LNG = LNG' - \sin^{-1} \frac{(\sin d)(\sin \emptyset)}{\cos [(LAT - LAT')/2]}$$

$$DIST = 60d$$

$$d = \cos^{-1}[\sin LAT \sin LAT' + \cos LAT \cos LAT' \cos (LNG - LNG')]$$

$$\alpha = \frac{\sin a}{\sin d}$$

$$\emptyset = TC = 270^\circ + \alpha \text{ or } 90^\circ - \alpha$$

$$a = \cos^{-1}(\sin LAT \sin LAT' + \cos LAT \cos LAT')$$

PROGRAM DESCRIPTION II

Sample Problem

Flight: Depart the McGhee Tyson airport, Knoxville, TN. Fly direct to COWAN intersection with waypoints of Hinch Mountain and Chattanooga VORTACs. Fly V54N to the Rocket VORTAC, V54 to Muscle Shoals VORTAC, and then direct to the Muscle Shoals, AL airport.

Card reader and printer are not used. The station coordinates are below:

McGhee Tyson (TYS)	35°48'45"N	83°59'34"W	1°W
Knoxville VORTAC (TYS)	35°54'17"N	83°53'41"W	1°W
Hinch Mt. VORTAC (HCH)	35°46'51"N	84°58'43"W	1°E
Chattanooga VORTAC (CHA)	34°57'40"N	85°09'12"W	1°E
Rocket VORTAC (RQZ)	34°47'49"N	86°38'02"W	2°E
Muscle Shoals VORTAC (MSL)	34°42'24"N	87°29'29"W	1°E
Muscle Shoals airport (MSL)	34°44'43"N	87°36'37"W	1°E

This route is depicted on the avigation chart following the sample problems.

SOLUTION:

Input	Function	Display	Comments
	XEQ RNAV	FROM?	Asking for departure fix
TYS	R/S	TYS LAT?	
35.4845	R/S	TYS LNG?	
83.5934	R/S	TYS VAR?	
1	R/S	TYS WP?	Asking if we want a terminal waypoint.
TYS (vortac)	R/S	TYS LAT?	
35.5417	R/S	TYS LNG?	
83.5341	R/S	TYS VAR?	
1	R/S	TYS * WP:TYS	Terminal waypoint from Knoxville Vortac for McGhee Tyson airport is 221.8° and 7.3 NM
	R/S	221.8, 7.3 NM	
	R/S	TYS TO?	Asking for ending fix for this leg
COWAN	R/S	COWAN LAT?	This is an intersection so input will be declined
	R/S	NEED FIX?	COWAN intersection is 277°, 38 NM DME from the Chattanooga VORTAC
CHA	R/S	CHA LAT?	
34.574	R/S	CHA LNG?	
85.0912	R/S	CHA VAR?	
1	CHS		Easterly variation is negative
-1	R/S	FIX RADIAL?	
277	R/S	FIX DIST?	
38	R/S	TYS TO WP?	Asking if we want waypoints
HCH	R/S	HCH LAT?	
35.4651	R/S	HCH LNG?	
84.5843	R/S	HVH VAR?	
1	CHS		
-1	R/S	TYS-WP:HCH	First leg identifiers
	R/S	MC=245/243	MC from Tys is 245° and MC to the waypoint off of the Hinch Mt. VORTAC is 243°.
	R/S	DIST=44 NM	Distance of first leg
	R/S	WP:HCH	Waypoint identifier and the WP
	R/S	153.1, 19.3 NM	bearing is 153.1 degrees and 19.3 NM DME
	R/S	WP:HCH TO WP?	Asking for the next waypoint

PROGRAM DESCRIPTION II

SOLUTION: **(CONTINUATION PAGE)**

Input	Function	Display	Comments
CHA	R/S	CHA LAT?	
34.574	R/S	CHA LNG?	
85.0912	R/S	CHA VAR?	
1	CHS		
-1	R/S	WP.HCH-WP:CHA	Second leg identifiers
	R/S	MC=243	
	R/S	DIST=29 NM	
	R/S	WP:CHA	
	R/S	333.1, 21.1 NM	
	R/S	WP:CHA TO WP?	Asking for another Waypoint
	R/S		Decline input to terminate the first primary leg
		WP:CHA-COWAN	Third leg identifiers
	R/S	MC=243	
	R/S	DIST=32 NM	
	R/S	COWAN TO?	Asking for next primary leg fix
RQZ	R/S	RQZ LAT?	
	R/S	NEED FIX?	Accidently declined LAT input
	R/S	FIX RADIAL?	Decline reference fix
	R/S		Decline prior fix for reference chance to change identifier
		RQZ	
	R/S	RQZ LAT?	Let's do it correct this time!
34.4749	R/S	RQZ LNG?	Don't mess up here! Or we will
86.3802	R/S	RQZ VAR?	have to start over.
2	CHS		
-2	R/S	COWAN TO WP?	No waypoint, so we'll decline
	R/S	COWAN-RQZ	Fourth leg identifiers
	R/S	MC=246/245	
	R/S	DIST=38 NM	
	R/S	RQZ TO?	
MSL (vortac)	R/S	MSL LAT?	
34.4224	R/S	MSL LNG?	
87.2929	R/S	MSL VAR?	
1	CHS		
-1	R/S	RQZ TO WP?	Decline input
	R/S	RQZ-MSL	Fifth leg identifiers
	R/S	MC=261/262	
	R/S	DIST=43 NM	
	R/S	MSL TO?	
MSL (airport)	R/S	MSL LAT?	
34.4443	R/S	MSL LNG?	
87.3637	R/S	MSL VAR	
1	CHS		
-1	R/S	MSL TO WP?	No waypoint, so decline input
	R/S	MSL-MSL	Sixth and last leg identifiers
	R/S	MC=291	
	R/S	DIST=6 NM	
	R/S	MSL TO?	End of trip, so decline input
	R/S	MSL WP?	Need a terminal waypoing for MSL?
	R/S		No so decline input
		TYS TO MSL	Start and destination identifiers
	R/S	T/DIST 192	Total trip distance in NM

PROGRAM DESCRIPTION II

Sample Problem

Flight: Depart the McGhee Tyson airport, Knoxville, TN. Fly direct to COWAN intersection with waypoints of Hinch Mountain and Chattanooga VORTACs. Fly V54N to the Rocket VORTAC, V54 to Muscle Shoals VORTAC, and then direct to the Muscle Shoals, AL airport.

A card reader and printer will be used. VORTAC identifiers will have the letter "V" added on to them to differentiate them from the airport identifiers. Write the data on a magnetic card using the sample problem in Data Record Program Description II. This route is depicted on the avigation chart following the sample problems.

Stations used and their identifiers:

McGhee Tyson airport	TYS
Knoxville VORTAC	TYSV
Hinch Mountain VORTAC	HCHV
Chattanooga VORTAC	CHAV
Rocket VORTAC	RQZV
Muscle Shoals VORTAC	MSLV
Muscle Shoals airport	MSL

SOLUTION:

Input	Function	Display	Comments
	XEQ RNAV	FROM?	Asking for departure fix
TYS	R/S	CARD	Load card for fix coordinates
	Load Data Card	TYS WP?	We'll use the TYS VORTAC for a terminal waypoint. Printer outputs waypoint data.
TYSV	R/S	TYS TO?	
COWAN	R/S	CARD	Intersection, so no card data
	R/S	COWAN	
	R/S	COWAN LAT?	We have no coordinates
	R/S	NEED FIX?	Yes, as the McGhee Tyson airport is not a good reference point. CHA VORTAC on the other hand is excellent because of the airway from it to the COWAN intersection. The chart shows COWAN to be 277°, 38 NM from CHA VORTAC.
CHAV	R/S	FIX RADIAL?	
277	R/S	FIX DIST?	
38	R/S	TYS TO WP?	Asking if we want waypoints
HCHR	R/S	CARD	We made an error
	R/S	HCHR	Yes, input should have been HCHV
	R/S	HCHR LAT?	
	R/S	HCHR	Correction may be made now
HCHV	R/S		Printer outputs Leg 1 and waypoint data
		WP:HCH TO WP?	
CHAV	R/S		Printer outputs Leg 2 and waypoint data
		WP:CHA TO WP?	
HCHV	R/S		Invalid waypoint, behind previous waypoint
		WP:CHA TO WP?	
	R/S		Input declined will terminate the first primary leg.
		COWAN TO?	Printer outputs leg 3 data
RQZ	R/S	CARD	Must have made an error
	R/S	RQZ	Yes, should have been RQZV
	R/S	RQZ LAT?	We will cycle through the prompts
	R/S	NEED FIX?	until we can correct it

PROGRAM DESCRIPTION II

SOLUTION: (CONTINUATION PAGE)

Input	Function	Display	Comments
	R/S	FIX RADIAL?	
	R/S	RQZ	Correction may be made now
RQZV	R/S	COWAN TO WP?	Want a waypoint?
CHAV	R/S	COWAN TO WP?	Invalid waypoint, before leg's starting fix.
MSLV	R/S	CARD	Load card for needed data
	Load data card	COWAN TO WP?	Invalid waypoint, beyond leg's ending fix. Didn't want a waypoint anyway.
	R/S	RQZV TO?	Printer outputs leg 4 data
MSLV	R/S	RQZV TO WP?	
	R/S		Printer outputs leg 5 data
		MSLV TO?	
MSL	R/S	MSLV TO WP?	
	R/S		Printer outputs leg 6 data
		MSL TO?	
	R/S		Flight is terminated
		MSL WP?	Don't need a terminal waypoint so we'll decline input
	R/S		
		TYS TO MSL	Printer outputs trip distance

PROGRAM DESCRIPTION II

SOLUTION: (CONTINUATION PAGE)

PRINTER OUTPUT:

```
TYS * WP:TYS
221.8°, 7.3 NM

TYS to WP:MCH
MC=245°/243°
DIST=44 NM

WP:MCH
153.1°, 19.3 NM

WP:MCH to WP:CHA
MC=243°
DIST=29 NM

WP:CHA
333.1°, 21.1 NM

WP:CHA to COWAN
MC=247°
DIST=32 NM

COWAN to ROZV
MC=246°/245°
DIST=38 NM

ROZV to MSLV
MC=261°/262°
DIST=43 NM

MSLV to MSL
MC=291°
DIST=6 NM


TYS TO MSL
T/DIST 192 NM
```

PROGRAM DESCRIPTION II

Sample Problem

While flying RNAV direct from the McGhee Tyson airport to the COWAN intersection on the way to Muscle Shoals, Alabama you are diverted around weather to the North. When clear of the weather, you are cleared from present position direct to the Muscle Shoals VORTAC. With the aircraft navigation receivers we can determine that we are 12 NM DME from the Hinch Mountain VORTAC on its 240° radial. One waypoint will be computed using the Shelbyville VORTAC.

A card reader will be used, but not a printer. VORTAC identifiers will have the letter "V" added on to them to differentiate them from an airport identifier. Write the data on a magnetic card using the sample problem in Data Record Program Description II. This route is depicted on the avigation chart following this sample problem.

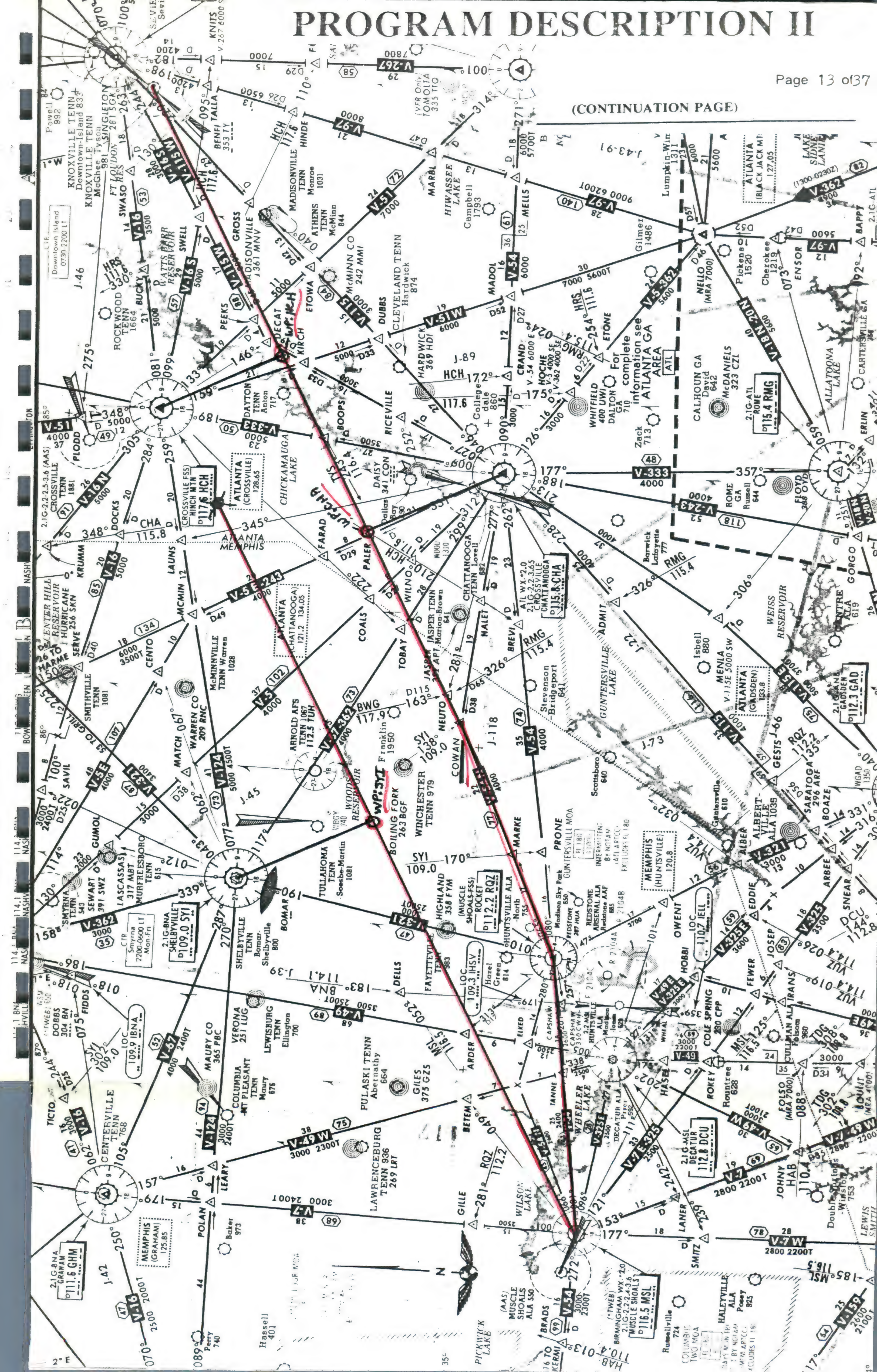
Stations used and their identifiers:

Hinch Mountain VORTAC	HCHV
Shelbyville VORTAC	SYIV
Muscle Shoals VORTAC	MSLV

SOLUTION:

Input	Function	Display	Comments
	XEQ RNAV	FROM?	Where are you at?
X	R/S	CARD	Position "X" isn't on a card, but load the data card for the next fix (Hinch Mt. VORTAC) to save having to push R/S twice to continue the program.
	Load Data Card	X LAT?	Coordinates are unknown
	R/S	NEED FIX?	Yes, we know our position relative to the Hinch Mountain VORTAC.
HCHV	R/S	FIX RADIAL?	
240	R/S	FIX DIST?	
12	R/S	X TO?	
MSLV	R/S	X TO WP?	
SYIV	R/S	X - WP:SYI	Data output
	R/S	MC=241/240	
	R/S	DIST=57 NM	
	R/S	WP:SYI	
	R/S	150.5, 21.6 NM	
	R/S	WP:SYI TO WP?	Don't want any more waypoints.
	R/S	WP:SYI - MSLV	Data output continues
	R/S	MC=240/241	
	R/S	DIST=70NM	
	R/S	MSLV TO?	The rest of the trip to MSL has already been computed.
	R/S	MSLV WP?	Don't need a terminal waypoint.
	R/S	X TO MSLV	
	R/S	T/DIST 127	

(CONTINUATION PAGE)



USER INSTRUCTIONS

SIZE: 35

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Size	35	XEQ SIZE	
2	Start program		XEQ RNAV	FROM?
3	Input departure airport/facility ident	IDENT'	R/S	(see part A)
	From step A2, A7, or part A skipped			IDENT' WP?
	From step A11 - skip step 4			IDENT' TO?
4	Input terminal waypoint fix identifier	$IDENT^{V}$	R/S	(see part A)
	From part A or part A skipped			IDENT' TO?
5	Input primary leg end fix identifier	IDENT	R/S	(see part A)
	From part A or part A skipped			IDENT' TO WP?
	Declined, skip to step 7		R/S	
6	Input waypoint reference fix identifier	$IDENT^{WP}$	R/S	(see part A)
	Input declined, go to step 5		R/S	IDENT TO?
	From part A or part A skipped, repeat step 6			$IDENT^{WP}$ TO WP?
7	Prior primary fix input from:			
	Step A11 - go to step 9.			
	Step A2, A7, or part A skipped			IDENT WP?
8	Input terminal waypoint fix identifier	$IDENT^{V}$	R/S	(see part A)
	Input declined or part A skipped, or from part A			
9	Program ends			
	Part A is on the next page and is the steps used to input data.			Above displays assumes that a printer was used to output leg and waypoint data.

USER INSTRUCTIONS

Part A: Data input

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
A1	If data is already loaded from a prior card, skip part A,			CARD
	or if card reader isn't used, skip to step A4			IDENT LAT?
A2	Load data card			
	Data not on the card, skip to step A4			IDENT LAT?
	Data on the card			Return to the original step
A3	Data card declined		R/S	IDENT
	Resume program execution		R/S	IDENT LAT?
A4	Input latitude	DD.MMSS	R/S	IDENT LNG?
	Input declined - skip to step A8			
A5	Inpute longitude	DD.MMSS	R/S	IDENT VAR?
A7	Input magnetic variation (+ W, - E)	DD	(CHS) R/S	Return to the original step
A8	Coordinates to be computed			
	If a waypoint is being computed, go to step A1			IDENT
A9	Input reference fix (uses steps A1 - A7)	IDENT	R/S	LEG RADIAL?
	Input declined (uses prior fix for reference)		R/S	LEG RADIAL?
A10	Input radial from the reference fix	DD.dd	R/S	LEG DIST?
	Input declined - go to step A1		R/S	IDENT
A11	Input distance from reference fix	NM	R/S	Return to the original step
	Explanation:			
	DD - Degrees			
	MM - Minutes of a degree			
	SS - Seconds of a degree			
	dd - Decimal fraction of a degree			

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "RNAV"	
02	CF 05	
03	CF 06	Initialize
04	CF 09	
05	SF 21	
06	CF 29	
07	DEG	
08	ADV	
09	"FROM?"	Departure point
10	SF 08	
11	SF 23	
12	XEQ 03	Coordinates
13	CF 08	
14	CLX	
15	STO 15	
16	RCL 06	
17	STO 14	Departure identifier
18	FC?C 07	Fix not a waypoint?
19	XEQ 11	Prompt for terminal WP
20	FIX 0	
21	*LBL 20	PRIMARY LEGS
22	ADV	
23	CLA	
24	ARCL 06	
25	ASTO 10	
26	"⊢ TO?"	
27	CF 23	
28	XEQ 03	Coordinates
29	FC? 23	Inpute declined?
30	GTO 22	
31	XEQ 10	True course & distance
32	STO 00	∅
33	RCL 02	Distance
34	RND	
35	ST+ 15	Distance sum
36	STO 05	Leg distance
37	RCL 11	
38	STO 16	Store the primary leg's
39	RCL 12	ending fix
40	STO 17	
41	RCL 13	
42	STO 18	
43	RCL 06	
44	STO 19	
45	0	
46	STO 04	
47	SF 09	Waypoints being computed
48	*LBL 21	SECONDARY LEGS
49	CLA	
50	ARCL 10	
51	"⊢ TO WP?"	
52	CF 23	
53	XEQ 03	Coordinates
54	FC? 23	Waypoint declined?
55	GTO 01	
56	"WP:"	
57	ARCL 06	
58	ASTO 06	
59	XEQ 10	$\emptyset^V$
60	STO 02	
61	180	
62	+	θ^V
63	90	
64	RCL 00	$\emptyset$
65	RCL 02	
66	-	α^{WP}
67	1	
68	P-R	
69	R-P	$-180^\circ \leq \alpha^{WP} \leq 180^\circ$
70	RDN	
71	X<0?	
72	SF 05	
73	ABS	$\lvert\alpha^{WP}\rvert$
74	STO 02	
75	-	β^{WP}
76	X<=0?	
77	GTO 21	WP behind starting fix?
78	STO 03	
79	FC?C 05	
80	CHS	
81	+	
82	RCL 11	VAR^V
83	+	Waypoint radial
84	X<> 03	β^{WP}
85	SIN	
86	RCL 01	Sin d^V
87	*	
88	ASIN	
89	60	
90	*	
91	RND	L
92	RCL 05	
93	X<=Y?	WP beyond ending fix?
94	GTO 21	
95	X<>Y	
96	RCL 04	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS
97	X>Y?	WP behind last WP?
98	GTO 21	
99	RDN	
100	ENTER↑	L
101	X<> 04	Last L
102	XEQ 02	Output Leg data
103	ADV	
104	FIX 1	
105	CLA	
106	ARCL 06	
107	XEQ 15	Output WP identifier
108	CLA	
109	RCL 03	WP radial
110	XEQ 12	Azimuth format
111	"⊢, "	
112	RCL 02	$\lvert \alpha^{wp} \rvert$
113	SIN	
114	RCL 01	Sin d^{v}
115	*	
116	ASIN	
117	60	
118	*	WP radial distance
119	ARCL X	
120	"⊢ NM"	
121	XEQ 15	Output WP data
122	RCL 11	
123	STO 07	VAR update
124	ADV	
125	FIX 0	
126	RCL 06	
127	STO 10	
128	GTO 21	
129	*LBL 01	
130	CF 09	
131	RCL 16	
132	STO 11	VAR update
133	RCL 19	
134	STO 06	
135	RCL 05	
136	RCL 04	
137	XEQ 02	Output leg data
138	RCL 11	
139	STO 07	Last leg's ending fix becomes the new leg's starting fix.
140	RCL 17	
141	STO 08	
142	RCL 18	
143	STO 09	
144	GTO 20	
145	*LBL 02	LEG OUTPUT Subroutine
146	-	
147	STO 12	Leg distance
148	CLA	
149	ARCL 10	
150	FC? 55	
151	GTO 00	
152	ACA	
153	CLA	
154	SF 13	
155	" TO "	Identifiers
156	ACA	
157	CF 13	
158	CLA	
159	*LBL 00	
160	FC? 55	
161	"⊢-"	
162	ARCL 06	
163	XEQ 15	Output
164	"MC="	
165	RCL 00	∅
166	RCL 07	VAR'
167	+	MC'
168	STO 13	
169	XEQ 12	Azimuth format
170	RCL 13	MC'
171	RCL 00	∅
172	RCL 11	VAR
173	+	MC
174	X≠Y?	
175	"⊢/"	
176	X≠Y?	Variation changed?
177	XEQ 12	Azimuth format
178	XEQ 15	Output magnetic course
179	"DIST="	
180	ARCL 12	Leg distance
181	"⊢ NM"	
182	GTO 15	Output leg distance
183	*LBL 03	COORDINATE INPUT Subroutine
184	13	
185	FS? 08	
186	9	
187	*LBL 04	
188	STO 01	
189	*LBL 05	
190	AON	
191	PROMPT	
192	AOFF	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM LISTING

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STEP/ LINE	KEY ENTRY	COMMENTS
193	FC? 23	Input declined?
194	RTN	
195	FC? 09	
196	CF 07	
197	ASTO 06	
198	20.03403	
199	STO 02	
200	STO 03	
201	XEQ 07	Data search
202	FS?C 05	Data found?
203	RTN	
204	RCL 03	
205	STO 02	
206	SF 25	
207	AON	
208	RDTAX	Prompt for data card
209	AOFF	
210	CF 25	
211	XEQ 07	Data search
212	FS?C 05	Data found?
213	RTN	
214	CF 22	
215	CLA	
216	ARCL 06	
217	"⊢ LAT?"	Latitude prompt
218	PROMPT	
219	CLA	
220	ARCL 06	
221	FC? 22	Input declined?
222	GTO 09	Intersection coordinates
223	HR	
224	STO IND 01	
225	DSE 01	
226	CLA	
227	ARCL 06	
228	"⊢ LNG?"	Longitude prompt
229	PROMPT	
230	HR	
231	STO IND 01	
232	DSE 01	
233	CLA	
234	ARCL 06	
235	"⊢ VAR?"	Magnetic Variation prompt
236	PROMPT	
237	STO IND 01	
238	RTN	
239	♦LBL 07	DATA SEARCH Subroutine
240	RCL 06	
241	RCL IND 02	
242	X=Y?	
243	GTO 08	
244	ISG 02	
245	GTO 07	
246	RTN	
247	♦LBL 08	COORDINATE DECODE Subroutine
248	SF 05	
249	1	
250	ST+ 02	
251	RCL IND 02	
252	HR	
253	STO IND 01	
254	DSE 01	
255	1	
256	ST+ 02	
257	RCL IND 02	
258	FRC	
259	LASTX	
260	INT	
261	ABS	
262	1 E4	
263	/	
264	HR	
265	STO IND 01	
266	DSE 01	
267	RDN	
268	100	
269	*	
270	STO IND 01	
271	RTN	
272	♦LBL 09	INTERSECTION Subroutine
273	FC? 09	WP or Reference fix?
274	FS? 06	
275	GTO 03	
276	RCL 07	Prior fix coordinates to be used for the reference fix.
277	STO 11	
278	RCL 08	
279	STO 12	
280	RCL 09	
281	STO 13	
282	RCL 06	
283	STO 16	
284	SF 06	Reference fix flag
285	CF 23	
286	13	
287	"NEED FIX?"	Prompt for reference fix if not prior fix
288	XEQ 04	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS
289	CF 06	
290	RCL 16	
291	STO 06	
292	"FIX RADIAL?"	Prompt for radial ∅
293	PROMPT	
294	CLA	
295	ARCL 06	
296	SF 23	
297	FC? 22	Input declined
298	GTO 03	
299	RCL 11	
300	FS? 08	Departure fix?
301	STO 07	
302	-	
303	STO 01	
304	"FIX DIST?"	Prompt for distance
305	PROMPT	
306	60	
307	/	d
308	SIN	
309	STO 02	Sin d
310	RCL 01	∅
311	SIN	
312	*	
313	ASIN	
314	RCL 01	
315	COS	
316	RCL 02	
317	*	
318	ASIN	
319	RCL 13	LAT'
320	+	
321	STO 13	LAT
322	FS? 08	Departure fix?
323	STO 09	
324	LASTX	
325	+	
326	2	
327	/	
328	COS	
329	/	
330	ST- 12	
331	RCL 12	LNG
332	FS? 08	
333	STO 08	
334	SF 07	
335	RTN	
336	LBL 10	TC & DISTANCE Subroutine
337	RCL 13	
338	SIN	
339	RCL 09	
340	SIN	
341	*	Sin LAT Sin LAT'
342	STO 01	
343	RCL 13	
344	COS	
345	RCL 09	
346	COS	
347	*	Cos LAT Cos LAT'
348	STO 02	
349	+	
350	ACOS	
351	SIN	Sin a
352	RCL 13	
353	RCL 09	
354	-	
355	SIGN	+ Northerly - Southerly
356	*	
357	RCL 02	
358	RCL 12	
359	RCL 08	
360	-	
361	X<0?	
362	SF 05	Easterly
363	COS	
364	*	
365	RCL 01	
366	+	
367	ACOS	d
368	SIN	Sin d
369	STO 01	
370	LASTX	
371	60	
372	*	DIST
373	STO 02	
374	RDN	
375	/	
376	ASIN	α
377	FS? 05	
378	CHS	
379	90	
380	+	
381	180	
382	FS?C 05	
383	CLX	
384	+	∅

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM LISTING

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STEP/ LINE	KEY ENTRY	COMMENTS
385	RTN	
386	♦LBL 11	TERMINAL WAYPOINT
387	RCL 06	Subroutine
388	STO 10	
389	CLA	
390	ARCL 06	
391	"⊢ WP?"	Terminal WP prompt
392	SF 09	Waypoint being computed
393	CF 23	
394	XEQ 03	Coordinates
395	CF 09	
396	FC? 23	Terminal WP declined?
397	RTN	
398	"WP:"	
399	ARCL 06	
400	ASTO 06	
401	CLA	
402	ARCL 10	
403	"⊢ * "	
404	ARCL 06	
405	XEQ 15	Output identifier
406	CLA	
407	RCL 10	
408	STO 06	
409	XEQ 10	$\not\angle^{V}$
410	180	
411	+	$\leftarrow^{V}$
412	RCL 11	VAR^{V}
413	+	
414	FIX 1	
415	XEQ 12	Azimuth format
416	"⊢, "	
417	RCL 02	$\angle^{V}$
418	ARCL X	
419	"⊢ NM"	
420	GTO 15	Output waypoint data
421	♦LBL 12	AZIMUTH Subroutine
422	360	
423	MOD	Degree format
424	X≠0?	
425	GTO 00	
426	LASTX	
427	+	
428	♦LBL 00	
429	100	
430	X>Y?	
431	"⊢0"	
432	SQRT	
433	X>Y?	
434	"⊢0"	
435	ARCL Y	
436	FC? 55	
437	RTN	
438	ACA	
439	0	Degree Character
440	ENTER↑	
441	BLDSPEC	
442	6	
443	BLDSPEC	
444	9	
445	BLDSPEC	
446	9	
447	BLDSPEC	
448	9	
449	BLDSPEC	
450	6	
451	BLDSPEC	
452	ACSPEC	
453	CLA	
454	RTN	
455	♦LBL 22	Destination
456	FC?C 07	Fix not a waypoint
457	XEQ 11	Prompt for terminal WP
458	ADV	
459	CLA	
460	ARCL 14	
461	"⊢ TO "	Terminal identifiers
462	ARCL 19	
463	AVIEW	
464	FIX 0	
465	"T/DIST "	
466	ARCL 15	Total trip distance
467	FS? 55	
468	"⊢ NM"	
469	♦LBL 15	OUTPUT Subroutine
470	FC? 55	
471	GTO 00	
472	ACA	
473	PRBUF	
474	RTN	
475	GTO "RNAV"	
476	♦LBL 00	
477	AVIEW	
478	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	True course
01	Scratch
02	Scratch
03	Scratch
04	WP distance
05	Leg distance
06	Identifier
07	VAR'
08	LNG'
09	LAT'
10	IDENT'
11	VAR
12	LNG
13	LAT
14	Departure Ident
15	Total distance
16	Ending-starting VAR
17	Ending-starting LNG
18	Ending-starting LAT
19	Ending-starting IDENT
20 to 34	CARD DATA

STATUS

SIZE 35 TOT. REG. 158 USER MODE

ENG ____ FIX ____ SCI ____ ON ____ OFF ____

DEG ____ RAD ____ GRAD ____

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05		Ident located Easterly course $\alpha^{wp} < 0$	Westerly course $\alpha^{wp} \leq 0$
06		Reference fix	
07		Terminal fix is a waypoint	
08		Departure fix	
09		Computing waypoint	

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY

Without Printer

If a printer is not going to be used, the program may be changed in order to reduce program size and running time. Total registers needed is 145.

Whenever a line is deleted or inserted it will change the line numbering for every line that follows it. In order to maintain orientation with the Program Listing while changing the program, start at the end of the program and work forward.

The steps below start at the end of the program and complete the needed changes.

Step	Command/Function	Comments
1.	GTO• 477	
	←	Delete AVIEW
	PROMPT	Insert PROMPT
2.	GTO• 467	
	DEL 010	Delete lines 467 thru 476
3.	GTO• 463	
	←	Delete AVIEW
	PROMPT	Insert PROMPT
4.	GTO• 458	
	←	Delete ADV
5.	GTO• 436	
	DEL 018	Delete lines 436 thru 453
6.	GTO• 420	
	←	Delete GTO 15
	PROMPT	Insert PROMPT
	RTN	Insert RTN
7.	GTO• 405	
	←	Delete XEQ 15
	PROMPT	Insert PROMPT
8.	GTO• 182	
	←	Delete GTO 15
	PROMPT	Insert PROMPT
	RTN	Insert RTN

Without Printer (CONTINUATION PAGE)

Step	Command/Function	Comments
9.	GTO• 178	
	←	Delete XEQ 15
	PROMPT	Insert PROMPT
10.	GTO• 163	
	←	Delete XEQ 15
	PROMPT	Insert PROMPT
11.	GTO• 150	
	DEL 011	Delete lines 150 thru 160
12.	GTO• 124	
	←	Delete ADV
13.	GTO• 121	
	←	Delete XEQ 15
	PROMPT	Insert PROMPT
14.	GTO• 107	
	←	Delete XEQ 15
	PROMPT	Insert PROMPT
15.	GTO• 103	
	←	Delete ADV
16.	GTO• 022	
	←	Delete ADV
17.	GTO• 008	
	←	Delete ADV
18.	GTO• 005	
	←	Delete SF 21

Without Card Reader

If a card reader is not going to be used, the program may be changed in order to reduce program size and running time. Total registers needed is 131; size will be 20.

Whenever a line is deleted or inserted it will change the line numbering for every line that follows it. In order to maintain orientation with the Program Listing while changing the program, start at the end of the program and work forward.

The steps below start at the end of the program and complete the needed changes.

Step	Command/Function	Comments
1.	GTO• 239	
	DEL 033	Delete lines 239 thru 271
2.	GTO• 216	
	←	Delete line 216
	←	Delete line 215
3.	GTO• 198	
	DEL 016	Delete lines 198 thru 213

Without Printer and Card Reader

If neither a printer or card reader is going to be used the program size and running time can be greatly reduced. The total registers needed will be 117 and the size needed is 20.

In order to make the changes easily and maintain orientation with the Program Listing, start making the changes as listed in RNAV Appendix A and continue through step 7. When you finish making the change in step 7 make the changes listed in RNAV Appendix B. Then go back to RNAV Appendix A and continue making the changes starting with step 8.

The steps are listed below:

RNAV Appendix A	Steps 1 thru 7
RNAV Appendix B	All the steps
RNAV Appendix A	Steps 8 thru 18

Home Base Fix

If you would like to program in a fix, such as the home base, on a permanent basis it is suggested that the following subroutine (LBL 06) be inserted after line 238. For illustration the Municipal Airport at Jonesboro, AR will be used, and its coordinates and identifier will be in parenthesis. That fix is: JBR, 35°49'52"N, 90°38'47"W, 4°E.

Step	Command/Function	Comments
1.	GTO• 238	
2.	LBL 06	Insert the subroutine
	RCL 06	
	(JBR)	Fix identifier
	ASTO Y	
	CLA	
	ARCL 06	
	X ≠ Y?	
	GTO 07	
	10	
	STO 02	
	(35.4952)	Fix latitude
	STO 11	
	(-903847.04)	Fix longitude & magnetic variation*
	STO 12	
	GTO 08	
3.	GTO• 201	
	←	Delete XEQ 07
	XEQ 06	Insert XEQ 06

*NOTE: Longitude & magnetic variation format is ±DDMMSS.MV where:

±: sign of the magnetic variation
DD: degree of longitude
MM: minutes of longitude
SS: seconds of longitude
MV: degree of magnetic variation

Degree Format

The HP-41C/CV computes angles which are given in degrees in the decimal degree format. This format is in degrees and fraction of a degree (DD.FD). The program needs the coordinates to be given in degrees, minutes, and seconds (DD.MMSS), which are changed to the decimal degree format with the HR function. This is done in lines 223 and 230 in subroutine LBL 05, and in lines 252 and 264 in subroutine LBL 08.

The Airport/Facility Directory, used in the United States, gives the coordinates in degrees, minutes, seconds. That is the reason the program uses that format. However, many use Jepp Charts and other publications which give the coordinates in a degree, minute, and fraction of a minute format (DD° MM.F" or DD.MMF) If this format is desired then insert the nine lines given below before each of the HR commands. This will convert the fraction of a minute to seconds so the HR command may then convert it to a decimal degree. If this program change is implemented and data cards used, then the coordinates are to be entered in the same format (DD.MMF) onto the data cards.

Program Lines

```
100
*
INT
LAST X
FRC
HMS
+
100
/
```

The lines above could be used as a subroutine. Add LBL 00 at the start of them and RTN at the end. Insert all eleven lines before LBL 09 (between lines 271 and 272). Insert XEQ 00 before each of the four HR commands.

Negative Longitude

If a card reader is used and if the longitudes are negative, the present card storage format will have a problem. On the cards, the longitude and magnetic variation are combined, with the sign being that of the variation.

In the Data Record Appendix changes are suggested that will solve the problem. If those changes are made then the following changes need to be made in the RNAV program. The register size will be 36 and total registers needed will be 158.

Step	Command/Function	Comments
1.	GTO. 267	
	DEL 003	Delete lines 267 thru 269
2.	1	Insert commands to recall the magnetic variation
	ST-02	
	RCL IND 02	
3.	GTO. 258	
	DEL 006	Delete lines 258 thru 263
4.	GTO. 198	
	←	Delete the old counter value
	20.03504	Insert the new counter value

PROGRAM DESCRIPTION I

Program Title DATA RECORD (DR)

Contributor's Name ROBERT A. TIMS

Address P.O. Box 643

City State University **State/Country** Arkansas **Zip Code** 72467

Program Description, Equations, Variables This program encodes the navigation fix data and writes it on a magnetic card. The data includes the identifier, latitude, longitude, and the magnetic variation.

The data may be viewed for correctness and change after it has been inputed and written on the card.

If a card track is loaded by the normal mode, the data may be viewed by declining input on the first prompt. Anytime during the program that a prompted Identifier is declined, the program will proceed to view the remaining data. After the program has prompted for all the data, it will write the data on a card track. After it has written the data it will then allow the data to be viewed. When the data is viewed it may be corrected by inputing the correct data and continuing. Viewing may be terminated during any display without changing storage register contents.

Necessary Accessories Card Reader

Operating Limits and Warnings It is recommended that the data be viewed for correctness after being written on a data card, whether it is the first time the data is written or after corrections have been made, to insure accuracy.

Reference(s) 82104A Card Reader Owner's Handbook

This program has been verified only with respect to the numerical example given in *Program Description II*. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Write the identifiers, coordinates, and magnetic variation of the following facilities on a magnetic card. Add the letter "V" to the end of each navaid identifier to show that it is a vortac and not an airport. View data for correctness.

McGhee Tyson airport	TYS	35°48'45"N	83°59'34"W	1°W
Knoxville VORTAC	TYS	35°54'17"N	83°53'41"W	1°W
Chattanooga VORTAC	CHA	34°57'40"N	85°09'12"W	1°E
Hinch Mountain VORTAC	HCH	35°46'51"N	84°58'43"W	1°E
Rocket VORTEC	RQZ	34°47'49"N	86°38'02"W	2°E
Shelbyville VORTAC	SYI	35°33'43"N	86°26'21"W	2°E
Muscle Shoals VORTAC	MSL	34°42'24"N	87°29'29"W	1°E
Muscle Shoals airport	MSL	34°44'43"N	87°36'37"W	1°E

SOLUTION:

Input	Function	Display	Comments
	XEQ DR	IDENT?	Facility identifier prompt
TYS	R/S	TYS LAT?	If input declined will view all the data groups.
35.4845	R/S	TYS LNG?	
83.5934	R/S	TYS VAR?	
1	R/S	IDENT?	If input declined will view next four data groups.
TYSV	R/S	TYSV LAT?	Mistake!
35.5341	R/S	TYSV LNG?	
83.5341	R/S	TYSV VAR?	
1	R/S	IDENT?	If input declined will view next three data groups
CHAV	R/S	CHAV LAT?	
34.574	R/S	CHAV LNG?	
85.0912	R/S	CHAV VAR?	
1	CHS	-1	Easterly variation
	R/S	IDENT?	If input declined will view next
HCHV	R/S	HCHV LAT?	two data groups.
35.4651	R/S	HCHV LNG?	
84.5843	R/S	HCHV VAR?	
2	CHS	-2	Mistake! (today is a Monday!)
	R/S	IDENT?	
RQZV	R/S	RQZV LAT?	If input declined will view the last data group.
34.4749	R/S	RQZV LNG?	
86.3802	R/S	RQZV VAR?	
2	CHS	-2	Easterly variation
	R/S	RDY 01 OF 01	Ready to write data card
	Insert Card	TYS	View data for correctness!
	R/S	TYS=35.4845	View latitude
	R/S	TYS=83.5934	View longitude
	R/S	TYS=1.0	View magnetic variation
	R/S	TYSV	View identifier
	R/S	TYSV=35.5341	Incorrect
35.5417	R/S	TYSV=83.5341	
	R/S	TYSV=1.0	
	R/S	CHAV	
	R/S	CHAV=34.5740	
	R/S	CHAV= 85.0912	

PROGRAM DESCRIPTION II

SOLUTION: (CONTINUATION PAGE)

Input	Function	Display	Comments
	R/S	CHAV=-1.0	Continue viewing data for
	R/S	HCHV	correctness
	R/S	HCHV=35.4651	
	R/S	HCHV=84.5843	
	R/S	HCHV=-2.0	Incorrect
1	CHS	-1	Easterly variation
	R/S	RQZV	
	R/S	RQZV=34.4749	
	R/S	RQZV=86.3802	
	R/S	RQZV=-2.0	
	R/S	RDY 01 OF 01	Ready to write data card
	Insert Card	TYS	View data again
(20 steps not shown)	R/S	...all data viewed	and found to be correct
	R/S	RDY 01 OF 01	Data is correct, terminate program
	R/S	Not applicable	Clip card corner
	XEQ VER	CARD	Verify track #1
	Insert Card	TYPE: D TR 01	Track #1 content verified
	XEQ DR	IDENT?	Write track #2 of the data card
SYIV	R/S	SYIV LAT?	
35.3343	R/S	SYIV LNG?	
86.2621	R/S	SYIV VAR?	
2	CHS	-2	Easterly variation
	R/S	IDENT?	
MSLV	R/S	MSLV LAT?	
34.4224	R/S	MSLV LNG?	
87.2929	R/S	MSLV VAR?	
1	CHS, R/S	IDENT?	
MSL	R/S	MSL LAT?	
34.4443	R/S	MSL LNG?	
87.3637	R/S	MSL VAR?	
1	CHS, R/S	IDENT?	Decline input and leave the last
	R/S	HCHV	two data groups as is.
	R/S	HCHV=35.4651	
	R/S	HCHV=84.5843	
	R/S	HCHV=-1.0	
	R/S	RQZV	
	R/S	RQZV=34.4749	
	R/S	RQZV=86.3802	
	R/S	RQZV=-2.0	
	R/S	RDY 01 OF 01	Ready to write data card
	Insert Card	SYIV	View data for correctness
(20 steps not shown)	R/S	...all data viewed	and found to be correct.
	R/S	(terminate program,	clip card corner
	XEQ VER	CARD	Verify track #2
	Insert Card	TYPE: D TR 01	Track #2 verified
			Card is now ready to use in the
			RNAV sample problems

USER INSTRUCTIONS

SIZE: 18

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Size	18	XEQ "SIZE"	
2	Start program		XEQ "DR"	IDENT?
3	Input identifier (6 characters or less)	IDENT	R/S	IDENT LAT?
	Input declined, skip to step 8		R/S	IDENT
4	Input latitude	DD.MMSS	R/S	IDENT LNG?
5	Input longitude	DD.MMSS	R/S	IDENT VAR?
6	Input magnetic variation (+W, -E)	DD	(CHS), R/S	
	Not all data groups input, go to step 3			IDENT?
	All data groups are input			RDY 01 OF 01
7	Write data card	Insert Card		IDENT
8	View identifier, (correct if necessary)	(IDENT)	R/S	IDENT=DD.MMSS
9	View latitude, (correct if necessary)	(DD.MMSS)	R/S	IDENT=DD.MMSS
10	View longitude, (correct if necessary)	(DD.MMSS)	R/S	IDENT=DD
11	View variation, (correct if necessary)	(DD)	R/S	
	All remaining data groups not viewed, go to step 8			IDENT
	Viewing and corrections completed			RDY 01 OF 01
12	If corrections were made, skip to step 7			
	No corrections, terminate program		R/S	

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "DR"	
02	.014	Counter value
03	STO 17	
04	*LBL 01	
05	CF 23	
06	"IDENT?"	Input Identifier
07	AON	
08	PROMPT	
09	AOFF	
10	FC?C 23	Input declined?
11	GTO 03	
12	ASTO 16	
13	ASTO IND 17	Store identifier
14	ISG 17	
15	CLA	
16	ARCL 16	
17	"⊢ LAT?"	
18	PROMPT	Input latitude
19	STO IND 17	
20	ISG 17	
21	CLA	
22	ARCL 16	
23	"⊢ LNG?"	
24	PROMPT	Input longitude
25	1 E4	
26	*	
27	CLA	
28	ARCL 16	
29	"⊢ VAR?"	
30	PROMPT	Input magnetic variation
31	SIGN	
32	X<>Y	
33	LASTX	
34	ABS	Encode LNG.VAR
35	100	
36	/	
37	+	
38	*	
39	STO IND 17	
40	ISG 17	
41	GTO 01	
42	*LBL 02	
43	.014	
44	STO 17	
45	WDTAX	Write data card
46	*LBL 03	
47	CLA	
48	AON	
49	ARCL IND 17	
50	PROMPT	
51	AOFF	View Identifier and correct
52	ASTO 16	
53	ASTO IND 17	Store
54	ISG 17	
55	FIX 4	
56	RCL IND 17	
57	CLA	
58	ARCL 16	
59	"⊢="	
60	ARCL X	
61	PROMPT	View latitude and correct
62	STO IND 17	Store
63	ISG 17	
64	RCL IND 17	
65	INT	
66	ABS	
67	1 E4	Decode longitude
68	/	
69	CLA	
70	ARCL 16	
71	"⊢="	
72	ARCL X	
73	PROMPT	View longitude and correct
74	1 E4	
75	*	
76	X<> IND 17	
77	FIX 1	
78	FRC	Decode variation
79	ABS	
80	ST+ IND 17	Store longitude and unviewed variation
81	LASTX	
82	SIGN	
83	ST* IND 17	
84	LASTX	
85	100	
86	*	
87	CLA	
88	ARCL 16	
89	"⊢="	
90	ARCL X	
91	PROMPT	View variation and correct
92	100	
93	/	
94	SIGN	
95	X<> IND 17	
96	LASTX	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
97	ABS		102	ST* IND 17	Store
98	X<>Y		103	ISG 17	
99	INT	Encode longitude and	104	GTO 03	
100	ABS	corrected variation	105	GTO 02	
101	+		106	END	Write data card

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00 to 15	Facility data		
16	Identifier		
17	Counter value		

STATUS

SIZE 18 TOT. REG. 47 USER MODE

ENG ____ FIX ____ SCI ____ ON ____ OFF ____

DEG ____ RAD ____ GRAD ____

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY

Negative Longitude

In the continental United States the longitudes are positive numbers, therefore the longitude and magnetic variation are combined, with the sign being that of the variation. This way, three storage registers are used per fix, and five fixes may be stored per card track. In the case of negative longitudes this will not be usable.

The storage format may be changed as is convienent as long as the Coordinate Decode subroutine, LBL 08, in the RNAV program is changed accordingly. The following are some suggested changes to store the data using four registers per fix, one register each for the identifier and for the latitude, longitude, and magnetic variation with each of their associated signs. This format will allow four fixes per card track and will need a total of 41 registers.

The corresponding changes to the RNAV program are given in the RNAV Appendix F.

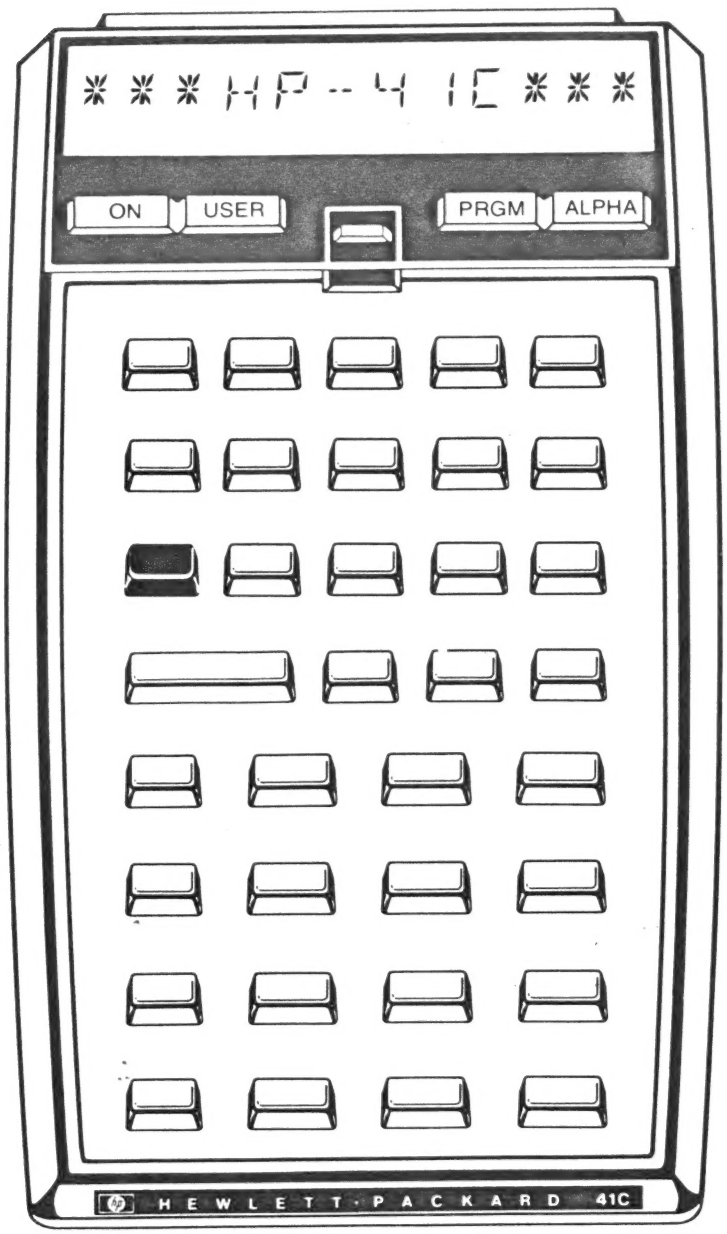
Step	Command/Function	Comments
1.	GTO• 092	
	DEL 011	Delete lines 92 thru 102
	STO IND 17	Insert this command
2.	GTO• 078	
	DEL 009	Delete lines 78 thru 86
3.	GTO• 074	
	DEL 003	Delete lines 74 thru 76
	STO IND 17	Insert these commands
	ISG 17	
	RCL IND 17	
4.	GTO• 065	
	DEL 004	Delete lines 65 thru 68
5.	GTO• 043	
	←	Delete old counter value
	.015	Insert new counter value
6.	GTO• 031	
	DEL 008	Delete lines 31 thru 38

Negative Longitude (CONTINUATION PAGE)

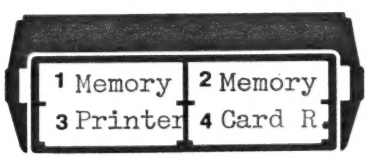
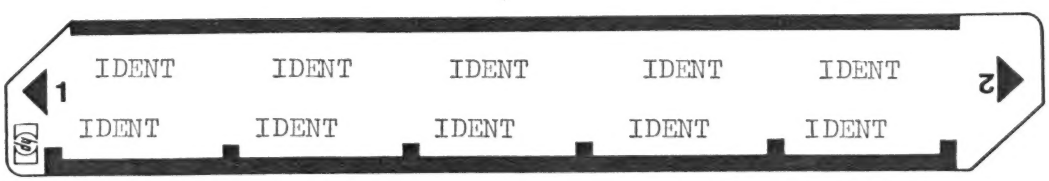
Step	Command/Function	Comments
7.	GTO• 026	
	←	Delete line 26
	←	Delete line 25
	STO IND 17	Insert these commands
	ISG 17	
8.	GTO• 002	
	←	Delete old counter value
	.015	Insert new counter value

KEYBOARD CARD LABELING

KEYBOARD



SYSTEM CONFIGURATION



CARD